159. A method of determining whether an asynchronous process should or should not be converted into a new periodic process, comprising:
(1) calculating a first processor capacity that is required for the asynchronous process if left unconverted,
(2) calculating a second processor capacity which is required to be reserved for the new periodic process,
(3) determining whether the ratio of said first processor capacity to said second processor capacity exceeds a predetermined threshold value.

160. A method as defined in claim 124, in which the determining step comprises
(1) calculating a first processor capacity that is required for the asynchronous process if left unconverted,
(2) calculating a second processor capacity which is required to be reserved for the new periodic process,
(3) determining whether the ratio of said first processor capacity to said second processor capacity exceeds a predetermined threshold value.

REMARKS - General

Applicant has written the new claims 158, 159, 160 to define the elected invention more particularly and distinctly so as to overcome the technical rejections and define the invention patentably over the prior art.

1. Applicant's wishes to include some further responses to the Office Action mailed September 10, 2003, which Applicant neglected to include in the previous Amendment D. Applicant also wishes to correct some mistakes Applicant made in Amendment D.

2. In item 27 of the last O.A., it was said that, "Referring to claim 83-85, 89, 91, 95, it is rejected for the same reasons as stated in the rejections of claims 58-64 and 76-79. In

addition, Dave also teaches the asynchronous process is to be delayed according to the assumptions ("delay", col. 2, lines 1-15 and 47-67, and "delay constraint", col. 5, lines 25-46).

In addition to item 27 of Amendment D, Applicant wishes to add the following comments:

Applicant submits that the above O.A. reference to Dave is a mistaken reference:
2.1. Applicant could not locate the word "delay" in col. 2, lines 1-15, and 47-67, but has located it instead in col. 3. line 4. In col. 3, line 4, the word delay refers to another reference that bears no relation to Applicant's claims.
2.2. The word "delay constraint", col. 5, lines 25-46, as Dave explains, refers to worst-case execution times ("delay constraint, i.e., the worst-case execution time", col. 5, lines 34-35). The word "delay constraint also bears no relation to Applicant's claims.
2.3. Claim 83-85, 89, 91, 95 are methods that relate to performing scheduling process executions at run-time. Dave does not deal with scheduling processes at run-time, and hence does not teach what Claim 83-85, 89, 91, 95 teach.
3. The last O.A. rejected dependent claim 97 on Dave, Dave2, and Lindsley. Claim 97 has been rewritten as new dependent claim 143 to define patentably over Dave, Dave2, and Lindsley and any combination thereof.

In item 34 of the last O.A., it was said that, "Referring to claim 97, it is rejected for the same reasons as stated in the rejections of claims 58-64 and 76-79. In addition, "Official Notice" is taken that both the concept and advantages of providing tables is well known and expected in the art. It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the feature of data tables to store data to the existing method for having a data structure that organizes the data for access. Dave also teaches the asynchronous process to be delayed according to the assumptions ("delay", col. 2, lines 1-15 and 47-67, and "delay constraint", col. 5, lines 25-46)."

Applicant respectfully disagrees with the above "Official Notice", and requests that documentary proof be provided, and the data be stated as specifically as possible, and the facts be supported, under M.P.E.P Section 2144.03 and 37 CFR 1.104(d)(2) for the "Office Notice" position that providing data tables in the context of claim 143, that is,

> "A method as defined in claim 115, including, during a pre-run-time phase, generating tables of safe start time intervals for the executions of asynchronous processes, wherein every periodic process in the pre-run-time schedule is scheduled to be executed strictly within its time slot, wherein for every point in time of the pre-run-time schedule, it is determined whether each asynchronous process should be delayed, under the assumption that the actual start time of execution of every periodic process is equal to the beginning time of its time slot, and the actual end time of execution of every periodic process is equal to the end time of its time slot, wherein for every point in time of the pre-run-time schedule, in the event said asynchronous process is to be delayed according to the assumptions, the point in time is set to be unsafe and recorded in a corresponding entry in the table for the point in time and said asynchronous process."

is well known and expected in the art and it would have been obvious to one of ordinary skill in the art at the time the invention was made to include this feature.

The reasons that Applicant disagrees with the above "Official Notice" are as follows:

3.1. Applicant could not locate the word "delay" in col. 2, lines 1-15, and 47-67, but has located it instead in col. 3. line 4. In col. 3, line 4, the word delay refers to another reference that bears no relation to Applicant's claims.

3.2. The word "delay constraint", col. 5, lines 25-46, as Dave explains, refers to worst-case execution times ("delay constraint, i.e., the worst-case execution time", col. 5, lines 34-35). The word "delay constraint also bears no relation to Applicant's claims.

3.3. Claim 97 is method that relatse to performing scheduling process executions at run-time. Dave does not deal with scheduling processes at run-time, and hence does not teach what Claim 97 teaches.

3.4. Providing data tables that provide the exact points where each asynchronous process must be delayed in the context of claim 97 where complex constraints including

exclusion relations and deadline constraints between asynchronous processes and periodic processes that have been scheduled into time slots must be satisfied, is certainly not obvious and well known in the art.

4. The last O.A. rejected dependent claim 98 on Dave, Dave2, and Lindsley. Claim 98 has been rewritten as new dependent claim 144 to define patentably over Dave, Dave2, and Lindsley and any combination thereof.

In item 35 of the last O.A., it was said that, "Referring to claim 98, it is rejected for the same reasons as stated in the rejections of claims 58-64. In addition, "Official Notice" is taken that both the concept and advantages of providing tables is well known and expected in the art. It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the feature of data tables to store data to the existing method for having a data structure that organizes the data for access. Dave also teaches the asynchronous process to be delayed according to the assumptions ("delay", col. 2, lines 1-15 and 47-67, and "delay constraint", col. 5, lines 25-46)."

Applicant respectfully disagrees with the above "Official Notice", and requests that documentary proof be provided, and the data be stated as specifically as possible, and the facts be supported, under M.P.E.P Section 2144.03 and 37 CFR 1.104(d)(2) for the "Office Notice" position that providing data tables in the context of claim 143, that is,

> A method as defined in claim 115, including, during a pre-run-time phase, generating tables of safe start time intervals for the executions of asynchronous processes, wherein every periodic process is scheduled to be executed strictly within its time slot in the pre-run-time schedule,
> wherein for selected points in time of the pre-run-time schedule, it is determined whether each asynchronous process should be delayed, under the assumption that the actual start time of execution of every periodic process is equal to the beginning time of its time slot, and the actual end time of execution of every periodic process is equal to the end time of its time slot, wherein for selected

points in time of the pre-run-time schedule, in the event said asynchronous process is to be delayed according to the assumptions, that point in time is set to be unsafe and recorded in a corresponding entry in the table for the point in time and said asynchronous process.

is well known and expected in the art and it would have been obvious to one of ordinary skill in the art at the time the invention was made to include this feature.

The reasons that Applicant disagrees with the above "Official Notice" are as follows:

4.1. Applicant could not locate the word "delay" in col. 2, lines 1-15, and 47-67, but has located it instead in col. 3. line 4. In col. 3, line 4, the word delay refers to another reference that bears no relation to Applicant's claims.

4.2. The word "delay constraint", col. 5, lines 25-46, as Dave explains, refers to worst-case execution times ("delay constraint, i.e., the worst-case execution time", col. 5, lines 34-35). The word "delay constraint also bears no relation to Applicant's claims.

4.3. Claim 98 is a method that relate to performing scheduling process executions at run-time. Dave does not deal with scheduling processes at run-time, and hence does not teach what Claim 98 teaches.

4.4. Providing data tables that provide the exact points where each asynchronous process must be delayed in the context of claim 98 where complex constraints including exclusion relations and deadline constraints between asynchronous processes and periodic processes that have been scheduled into time slots must be satisfied, is certainly not obvious and well known in the art.

5. The last O.A. rejected dependent claim 104 on Dave, Dave2, and Lindsley. Claim 104 has been rewritten as new dependent claim 115 to define patentably over Dave, Dave2, and Lindsley and any combination thereof.

Applicant submits that claim 115 is independently patentable over Dave, Dave2, and Lindsley and any combination therefore for the same reasons as given in item 15 above.

The last O.A. said that "Dave fails to explicitly teach a method as defined in claim 58, wherein said predetermined constraints and relations further comprise precedence relations. However, "Official Notice" is taken that both the concept and advantages of providing that predetermined constraints can be comprised of precedence relations is well known and expected in the art. It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the feature of having precedence constraints as predetermined constraints to the existing method for the reason of using current/recent data into the system."

Applicant respectfully disagrees with the above "Official Notice", and requests that documentary proof be provided, and the data be stated as specifically as possible, and the facts be supported, under M.P.E.P Section 2144.03 and 37 CFR 1.104(d)(2) for the "Office Notice" position that predetermined constraints can be comprised of precedence relations in the context of claim 115, i.e.,

"A method of scheduling on one or more processors, executions of a plurality of periodic and asynchronous processes, comprising:

(A)

automatically generating a pre-run-time schedule comprising mapping from a set of periodic process executions to a sequence of time slots on one or more processor time axes, each of the time slots having a beginning time and an end time, reserving each one of the time slots for execution of one of the periodic processes, the positions of the end time and the beginning time of each of the time slots being such that execution of the periodic processes,

including satisfaction of predetermined constraints comprising

(1) worst-case computation times for periodic processes and asynchronous processes,

(2) period for periodic processes,

(3) minimum time between two consecutive requests for asynchronous processes,

(4) deadline for periodic processes and asynchronous processes,

(5) permitted range of offset constraints for periodic processes wherein a permitted range of offset of a periodic process comprising an interval that begins at a lower bound value and ends at an upper bound value which may be equal to the lower

bound value, the duration of the time interval between the beginning of the first period of said periodic process and time zero must be greater than or equal to said lower bound value and less than or equal to said upper bound value,

(6) precedence relations for periodic processes wherein each precedence relation being defined between a pair of processes comprising a first process and a second process, both said first process and said second process being periodic processes, said first process precedes said second process, execution of said second process only allowed to start after said first process has completed its execution,

(7) exclusion relations for periodic and asynchronous processes wherein each exclusion relation being defined between a pair of processes comprising a first process and a second process, said first process being either a periodic process or an asynchronous process and said second process being either a periodic process or an asynchronous process, said first process excludes said second process, no execution of said second process being allowed to occur between the time that said first process starts its execution and the time that said first process completes its computation,

can be completed between the beginning time and end time of respective time slots, including the step of converting one or more asynchronous processes into corresponding new periodic processes prior to the mapping step, and mapping new periodic processes to time slots in a manner similar to mapping of other periodic processes, such that said predetermined constraints will be satisfied

(B)

during run-time using the information in the pre-run-time schedule, including the positions of the beginning time and end time of the time slots of the periodic processes, to schedule the process executions, such that said predetermined constraints will be satisfied."

is well known and expected in the art. It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the feature of having precedence constraints as predetermined constraints to the existing method for the reason of using current/recent data into the system."

The reasons that Applicant disagrees with the above "Official Notice" are as follows:
5.1. Applicant's invention is classified in a **crowded art** (a prior art patent cited by the O.A. states that, *"There is a vast amount of literature in the area of scheduling of soft and hard aperiodic tasks", Dave, col. 2, lines 47-48*); therefore, even a small step forward should be regarded as significant.
5.2. How to integrate precedence constraints with many other types of complex constraints while at the same time providing proof and guarantee that all specified constraints will be met before run-time can be very complex and unobvious. This is underscored by the fact that, the most widely known and most intensively studied techniques of scheduling, priority scheduling, still has not been able to provide a proof and guarantee that all specified constraints will be met before run-time when the specified constraints include general precedence relations combined with other complex constraints such as exclusion constraints and offset constraints despite more than four decades of intensive research.

6. The last O.A. rejected dependent claim 77 on Dave, Lindsley and Matsumoto. Claim 77 has been rewritten as new dependent claim 160 to define patentably over Dave, Lindsley and Matsumoto and any combination thereof.

The last O.A. said that, *"Referring to claim 77, Dave fails to explicitly* teach prior to generating the pre-run-time schedule, determining whether each asynchronous process should or should not be converted into a new periodic process by a ratio or processing capacity. However, Matsumoto teaches a method of determining whether each asynchronous process should or should not be converted into a new periodic process by calculating whether a ratio of processing capacity of the processor which is required to be reserved for new periodic processes, to processor capacity that is required for the asynchronous process if left unconverted, exceeds a predetermined threshold value. *("Each of [1], [2], and [3] is a condition for improving the theoretical effectiveness, and each of [4] and [5] is a condition for doing the same by determining "n" heuristically, or*

from experience. Depending on the application which is running, "n" is adjusted in order to improve efficiency. With respect to conditions [4] and [5], instead of the number of processes waiting for synchronization, the ratio of the number of processors in the group to the number of processors waiting for synchronization in the group is used," col. 6, lines 25-35). It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the feature of synchronizing with respects to a ratio value of processing capacity for the reason of increasing the control of the system. This ratio tells the processor when it can stop waiting for synchronization to begin, for example. As mentioned earlier, it is common knowledge in the art of task management and process synchronization that converting asynchronous processes to synchronous ones is merely synchronization. In addition, Dave in view of Lindsley, and in further view of Matsumoto fail to explicitly teach using predetermined thresholds to determine a state in change. However, "Official Notice" is taken that both the concept and advantages of providing that the use of thresholds is well known and expected in the art. It would have been obvious to one of ordinary skill in the art at the time the invention was made to include thresholds to the existing method for the reason of increasing the control by being able to set limits or boundaries which determine one state over another. In this specific case, synchronization would begin after the threshold is reached." (Last O.A.)

Applicant respectfully disagrees with the above "Official Notice", and requests that documentary proof be provided, and the data be stated as specifically as possible, and the facts be supported, under M.P.E.P Section 2144.03 and 37 CFR 1.104(d)(2) for the "Office Notice" position that the use of thresholds is well known and expected in the art in the context of claim 160, i.e.,

" A method as defined in claim 124, in which the determining step comprises

(1) calculating a first processor capacity that is required for the asynchronous process if left unconverted,

(2) calculating a second processor capacity which is required to be reserved for the new periodic process,

(3) determining whether the ratio of said first processor capacity to said second processor capacity exceeds a predetermined threshold value.

would have been obvious to one of ordinary skill in the art at the time the invention was made to include thresholds to the existing method for the reason of increasing the control by being able to set limits or boundaries which determine one state over another. In this specific case, synchronization would begin after the threshold is reached."

6.1. Matsumoto fails to show any of the important features of claim 160. The quoted phrases, "*of processes waiting for synchronization, the ratio of the number of processors in the group to the number of processors waiting for synchronization in the group is used,"(* Matsumoto *col. 6, lines 25-35*) bear no relation to converting an asynchronous process to a new periodic process. It does not show how to calculate the processor capacity that is required for the asynchronous process if left unconverted, or the processor capacity which is required to be reserved for the new periodic process. Matsumoto fails to show any of the features of claims 115 and 124, on which 160 is based. Matsumoto does not even have the notion of timing constraints, such as periods, worst-case computation times, deadlines, etc.

6.2. The art of how to convert an asynchronous process to a new periodic process is not merely "synchronization" as suggested by the last O.A., it is one of the most important, yet least understood, and under-studied techniques in the field of real-time computing. Applicant's papers related to real-time computing have been reprinted in two IEEE Computer Society Tutorial collections and are also widely referenced in textbooks on real-time systems. Applicant is internationally well-known as an expert in real-time computing, and Applicant has taken a special interest in this particular technique for over 20 years, yet it had taken Applicant many, many years before Applicant realized and invented the technique shown by claim 160, hence Applicant can attest to the fact that the technique shown in claim 160 is far, far from obvious.

3. As can been seen in Fig. 26 of the drawings, and paragraph [0174], determining the ratio of processing capacity of the processor which is required to be reserved for new periodic processes, to processor capacity that is required for the asynchronous process if left unconverted, requires an elaborate procedure that is far from obvious. Hence Applicant is not surprised at all by the fact that no prior art has been found that meets the

features shown in claim 160, because, to Applicant's knowledge, up to even today, no one has published a similar invention.

6.3. Matsumoto readily acknowledges that his method may include processes that are deadlocked *("All of the processes in the group of processes concerned are dispatched to processors and waiting for synchronization at one time; this event occurs due to programming errors (deadlock)."col. 6, lines 5-9.)* Thus any combination involving Matsumoto will be inoperative, not only because of deadlocks, but in general due to the inability to deal with any timing constraints.

Please include all the comments in item 44 in Amendment D that relate to the claim 126 in my response regarding claim 77, which was first rewritten as new claim 126, and now is rewritten as claim 160.

8. The last O.A. rejected dependent claim 108 on Dave, Dave2, Lindsley, and Matsumoto. Claim 108 has been rewritten as new dependent claim 126 to define patentably over Dave, Dave2, Lindsley, and Matsumoto and any combination thereof. Applicant submits that claim 126 is independently patentable over Dave, Dave2, Lindsley, and Matsumoto and any combination therefore for the same reasons as given in item 43, and item 15 in Amendment D and in item 6 above.

9. The last O.A. rejected dependent claim 114 on Dave, , Lindsley, and Matsumoto. Claim 108 has been rewritten as new dependent claim 152 to define patentably over Dave, , Lindsley, and Matsumoto and any combination thereof.
Applicant submits that claim 152 is independently patentable over Dave, Lindsley, and Matsumoto and any combination therefore for the same reasons as given in item 43, and item 15 in Amendment D and in item 6 above.

Conclusion

For all of the above reasons, Applicant submits that the drawings and claims are now in proper form and that the claims all define patentably over the prior art. Therefore Applicant submits that this application is now in condition for allowance, which action Applicant respectfully solicits.

Conditional Request For Constructive Assistance

Applicants have amended the drawings and claims of this application so that they are proper, definite, and define novel structure which is also unobvious. If, for any reason this application is not believed to be in full condition for allowance, applicants respectfully request the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. § 2173.02 and § 707.07(j) in order that the undersigned can place this application in allowable condition as soon as possible and without the need for further proceedings.

Very respectfully,

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